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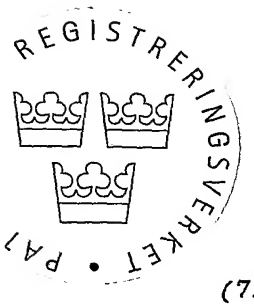

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Direct transition to CELL_DCH

FIELD OF THE INVENTION

The present invention relates to a method and arrangement to achieve an improved Cell Update message format in a UMTS Radio Access Network (UTRAN).

BACKGROUND OF THE INVENTION

In UTRAN a user equipment (UE) can be in one of several RRC states depending on the user activity. These states consist of Idle Mode, URA_PCH, CELL_PCH, CELL_FACH and CELL_DCH, listed in order of increasing user activity.

The CELL_DCH state provides the best user performance in terms of data rate and delay, but also consumes the most resources, e.g. in terms of power and codes. Thus it may be necessary to move users to lower states when the data transmission stops. A typical case for many applications is that data transmission occurs so seldom that the UE is in CELL_PCH or URA_PCH state when a data burst transmission starts. This implies that the delay to move from CELL_PCH/URA_PCH to CELL_DCH needs to be minimized, in order to have a good user performance. If the application transmits small data objects the time to change state will have a more significant impact on the user performance than the data rate on DCH. A Push-to-Talk service is one example, where rather small objects are transmitted rather infrequently. This service could start with a burst from the network side if the terminal in CELL PCH/URA PCH is the receiver of the talk burst. In this the delay for

transmitting a data object (including transition to CELL_DCH) is to a large extent determined by the time to move from CELL/URA_PCH to CELL_DCH.

When a UE in CELL/URA_PCH needs to transmit uplink data, the typical signalling sequence is shown in figure 1. In step 1, the UE sends a Cell Update message to indicate that it has uplink data available to transmit. In step 2, UTRAN responds with transmitting a Cell Update Confirm message which acknowledges the Cell Update Message and orders the UE to enter CELL_FACH state, where data transmission is possible. In step 3, The UE transmits a UTRAN Mobility Information Confirm message to acknowledge the Cell Update Confirm message. It is now possible for the UE to transmit data on RACH, i.e. it is in CELL_FACH state. If the available amount of data, which is denoted the Traffic Volume in 3GPP specifications, is above a configured threshold the UE transmits a Measurement Report to inform UTRAN about the available amount of data (step 4). When UTRAN receives the Measurement Report it can decide to move the UE to CELL_DCH since the RACH has very limited performance. UTRAN therefore sends a Radio Bearer Reconfiguration message in step 5 to move the UE to CELL_DCH. The UE responds with a Radio Bearer Reconfiguration Confirm message in step 6, which acknowledges the received message. Now the UE has entered CELL_DCH and can transmit data on the DCH.

Correspondingly, figure 2 depicts the typical signalling sequence when a UE in CELL/URA_PCH needs to receive downlink data. The UE receives in step 1 a paging message. The UE shall answer such a paging message. In step 2, the UE answers the paging message by sending a Cell Update message to indicate that it has received the paging mesage. In step 3, UTRAN responds with transmitting a Cell Update Confirm message which acknowledges the Cell Update Message and order

the UE to enter CELL_FACH state, where data transmission is possible. In step 4, The UE transmits a UTRAN Mobility Information Confirm message to acknowledge the Cell Update Confirm message. It is now possible for the UE to receive data on FACH (i.e. it is in CELL_FACH state). If the available amount of data buffered for this UE in the RNC (denoted Traffic Volume in 3GPP specifications) is high enough as evaluated by UTRAN, it can decide to move the UE to CELL_DCH since the FACH has very limited performance. UTRAN therefore sends a Radio Bearer Reconfiguration message in step 5 to move the UE to CELL_DCH. The UE responds with a Radio Bearer Reconfiguration Complete message in step 6, which acknowledges the received message. Now the UE has entered CELL_DCH and can receive data on the DCH.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a normal signalling sequence for moving a UE from CELL/URA_PCH to CELL_DCH in case of a UE initiated transmission.

Figure 2 shows a normal signalling sequence for moving a UE from CELL/URA_PCH to CELL_DCH in case of a UTRAN initiated transmission.

Figure 3 shows an alternative signalling sequence for moving a UE from CELL/URA_PCH to CELL_DCH in case of a UE initiated transmission.

Figure 4 shows an alternative signalling sequence for moving a UE from CELL/URA_PCH to CELL_DCH in case of a UTRAN initiated transmission.

Figure 5 shows an enhanced signalling sequence for moving a UE from CELL/URA_PCH to CELL_DCH in case of a UTRAN initiated transmission.

Figure 6 shows an enhanced signalling sequence for moving a UE from CELL/URA_PCH to CELL_DCH in case of a UTRAN initiated transmission with pre-configuration of the physical channel configuration to be used on DCH.

DESCRIPTION OF THE INVENTION

Another alternative for moving a UE from CELL/URA_PCH to CELL_DCH is depicted by help of figure 3. According to this alternative it would also be possible with the current 3GPP specifications to order the UE to CELL_DCH directly in the Cell Update Confirm message. This would result in a signalling sequence as shown in figure 3. In this alternative, the UTRAN orders the UE to CELL_DCH already in the Cell Update Confirm Message in step 2. The UE responds with a Radio Bearer Reconfiguration Complete message in step 3 and can then start to transmit data on DCH.

Correspondingly, figure 4 shows an alternative signalling sequence for moving a UE from CELL/URA_PCH to CELL_DCH in case of a UTRAN initiated transmission. Here, the UTRAN orders the UE to CELL_DCH already in the Cell Update Confirm Message in step 3. The UE responds with a Radio Bearer Reconfiguration Complete message in step 4 and can then start to receive data on DCH.

The alternative signalling sequence for UE initiated transmission described above by help of figure 3 is much faster than the normal sequence. In practice the time to move from CELL/URA_PCH to CELL_DCH can be more than halved.

However, this alternative sequence also implies the problem that the UTRAN has no information about the amount of data that the UE has available for transmission. The Cell Update message only contains a cause value indicating the cause for the cell update, in this case "uplink data transmission".

This means that the UTRAN has to move the UE to CELL_DCH without knowing if this is necessary or even desired. For small data objects the transmission time on CELL_FACH is smaller than on CELL_DCH due to the relatively large delay to setup the DCH channel. Thus it would in fact reduce the user performance if the UE is moved to CELL_DCH when the available amount of data is small. Given that it consumes network resources to move users to DCH, these resources are wasted if the UE is moved to DCH when there is no need.

It is known that the Cell Update message can be extended with a traffic volume measurement. However, due to limitations on the air interface and the fact that the Cell update is transmitted on RLC transparent mode it is not desirable to extend the message size to the extent that would be needed.

A solution to the problem described above is to modify the Cell Update message in a way that provides certain information about the traffic volume without significantly increasing the message size. The general idea is that instead of indicating the Traffic Volume explicitly, it is indicated in relation to a threshold, e.g. if the Traffic Volume is above a previously configured threshold. This threshold can be configurable by UTRAN. Normally the traffic volume measurements in the UE are configured in such a way that measurement reports in CELL_FACH are transmitted if the traffic volume exceeds a threshold and potentially the same value as used to trigger the transmission of a measurement

report could be used for setting the flag in the Cell update message. This method would mean that no downlink signalling would need to be changed. However, the threshold for the Cell Update message can also be configured separately.

In addition to the Traffic Volume information it could be beneficial to indicate further information, e.g. if the uplink data is available on a user radio bearer or a signalling radio bearer. This could potentially also be indicated in the cell update message. The benefit with this additional info would be that the UTRAN may choose not to move UEs to CELL_DCH if the data comes from a signalling radio bearer since the transmission on signalling radio bearers is not expected to be extended in time.

In order to reduce the DCH setup time from CELL_PCH and URA_PCH it is an object of the present invention to be able to perform a direct switch to CELL_DCH. To facilitate a direct switch the present invention proposes to modify the format of the CELL_UPDATE message to indicate, e.g., whether the UE has a traffic volume above a configured threshold, which is preferably the same as the threshold for triggering of the traffic volume measurement. As it would imply a significant increase of the size of an enhanced CELL_UPDATE message with the information about the available UL traffic volume such that it would no longer fit into one RLC PDU, an alternative is to indicate with a flag if the traffic volume is, e.g., above the traffic volume threshold configured for the traffic volume measurement. This information is considered sufficient to assist the UTRAN in the decision if a UE should be moved to CELL_DCH or not and could facilitate the direct transfer to CELL_DCH from CELL/URA_PCH.

The following describes by means of non-limiting examples two conceivable embodiments to indicate said information.

In a first embodiment the Cell Update message is extended with a flag, e.g. a single bit, indicating the relation to a threshold value, e.g. if the traffic volume in the UE is above a threshold. Potentially a second bit is used to be able to separate if the traffic volume is available on an SRB or an RB (or both). This would extend the message size with a few bits including those needed for coding of the message extension.

Another embodiment of the present invention uses currently reserved Code points. In the current cell update message there exist some spare values, i.e. code points that are currently not used but could be transmitted with the existing message coding. Thus, it would be a possible embodiment of the present invention to use one of the reserved code points in the Cell Update message to indicate the Traffic Volume, e.g. if the Traffic Volume is above the threshold. Potentially, up to several code points are used to be able to separate if the traffic volume is available on an SRB or an RB (or both). For example, a code point I could indicate a Traffic Volume above the threshold on an RB, a code point II could indicate a Traffic Volume above the threshold on an SRB, and a code point III could indicate a Traffic Volume above the threshold on both SRB and RB. This method would not increase the message size at all.

The method according to the present invention makes it possible to move user equipments quickly to CELL_DCH in case the traffic volume is large and to move user equipments to CELL_FACH in case the traffic volume is small. The method facilitates direct transition to DCH which reduces the DCH setup time significantly. The method can thus greatly improve the performance for applications where the UE is typically in CELL_URA_PCH when data needs to be transmitted, e.g. web surfing.

Turning back to figure 4, the alternative signaling sequence for UTRAN initiated transmission described in said figure could be seen as somewhat faster than the sequence in figure 2. However, since UTRAN have all the knowledge about the downlink buffers for this UE and know already when sending the Paging type 1 message that the UE should be moved to CELL_DCH state, there is no need to have the UE go via the CELL_FACH state before continuing the transition to CELL_DCH state. Performing Cell update procedure in CELL_FACH state (step 2 and 3 in figure 4) takes a substantial amount of time since the messages are sent on contention based common channels used by several users. By removing these steps in CELL_FACH state the sequence could therefore be made even faster if the UE transits directly from CELL_PCH/URA_PCH to CELL_DCH. This faster sequence is currently not supported in the 3GPP specifications.

When a UTRAN initiated transition from CELL_PCH/URA_PCH to CELL_DCH is performed the UE shall transit directly to CELL_DCH without exchanging messages in CELL_FACH state in between. The CELL_PCH/URA_PCH transition to CELL_DCH would be made faster if the paging message would contain the DCH configuration. This would result in a signaling sequence as shown in figure 5. In this alternative, the UTRAN orders the UE to CELL_DCH already in the Paging type 1 message in step 1. The UE responds with a Radio Bearer Reconfiguration Complete message in step 2 and can then start to receive data on DCH. In order to make this solution possible a number of information elements need to be added to the paging type 1 message. In fact the same content that is present in cell update confirm in figure 4 should be added to the paging message. Also compared to the content of cell update confirm the identity used in the paging type 1 message is U-RNTI and not C-RNTI.

Additional message content to the paging type 1 message would be:

Frequency, UL DPCH info (e.g. scrambling code, spreading factor, TFCI configuration), DL DPCH info (e.g. spreading factor, rate matching, power offsets) DL RL info (e.g. primary CPICH), power control configurations and potential HS-DSCH configurations.

Some other information related to RB and Transport channels could also be beneficial, but since the paging type 1 message is sent in TM mode and without segmentation or re-transmissions the size need to be limited, only the crucial information have been listed here.

It could be noted that normally the cell where the UE is located is not known when the UE is in URA_PCH state, so the invention is of limited use for this scenario. This is because UTRAN need to know already when sending the paging message in which cell the UE is located in order not to establish a dedicated channel for the UE in all cells belonging to the URA. This could of course be done but would potentially mean waste of radio resources.

Therefore the invention is in particular beneficial for CELL_PCH UEs. For URA_PCH Ues there is a benefit in case the UE has made its presence in a cell known to UTRAN rather recently.

There are two possibilities to indicate the information:

Explicit indication: The Paging type 1 message is extended with the explicit information needed to perform the direct transition to CELL_DCH.

Implicit indication: In order to save space in the paging type 1 message previous messages (e.g. a RB reconfiguration message) moving the UE to CELL_PCH/URA_PCH could include most of the configurations needed to perform the direct transition to CELL_DCH at a later stage. The paging type 1 message itself that could be sent a long time later, then only includes the actual code that the UE should use and/or a pointer to the already sent physical channel configuration. As an alternative to extending the paging message with DCH information, the Cell Update Confirm message could be modified to be transmitted on the paging channel (step 1 in figure 5). The method makes it possible to move UEs quickly to CELL_DCH in case the traffic volume is large. The method facilitates direct transition to DCH which reduces the DCH setup time significantly. The method can greatly improve the performance for applications where the UE is typically in CELL_PCH/URA_PCH when data needs to be transmitted to the UE (e.g. Push-to-Talk services).

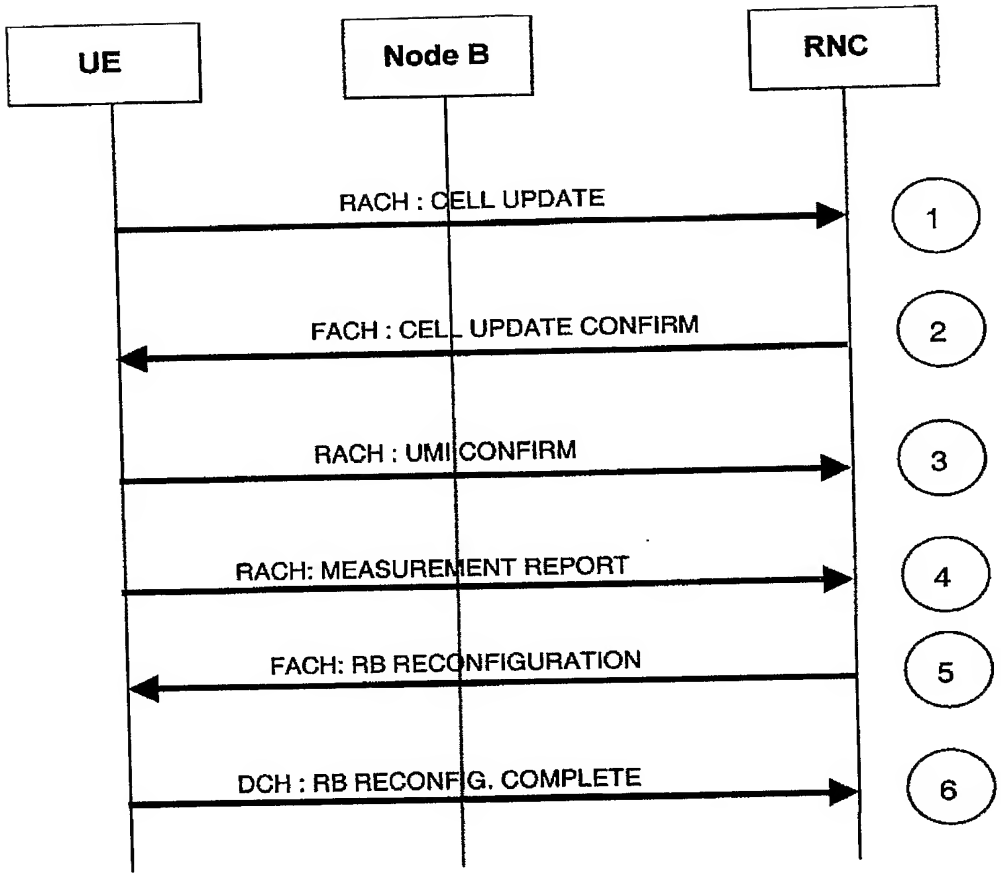
UE
Node B
RNC
RACH : CELL UPDATE
1
FACH : CELL UPDATE CONFIRM
2
RACH : UMI CONFIRM
3
RACH: MEASUREMENT REPORT
4
FACH: RB RECONFIGURATION
5
DCH : RB RECONFIG. COMPLETE
6

Fig. 1

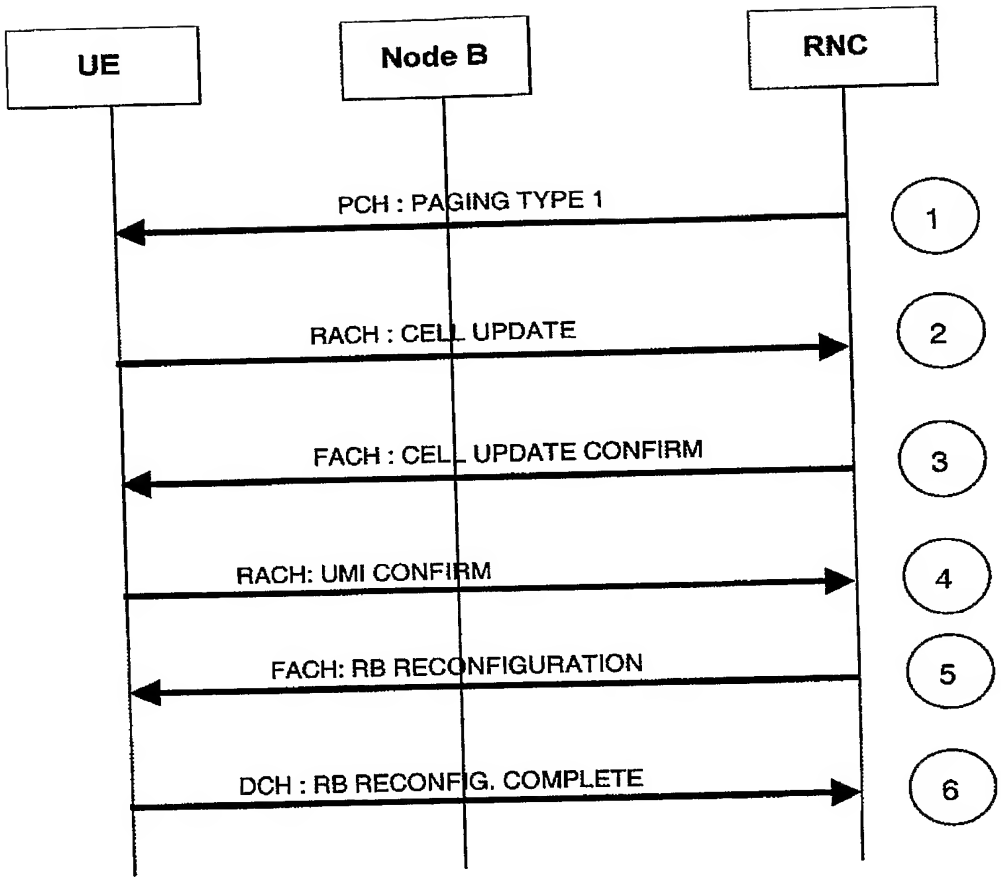
UE
Node B
RNC
PCH : PAGING TYPE 1
1
RACH : CELL UPDATE
2
FACH : CELL UPDATE CONFIRM
3
RACH: UMI CONFIRM
4
FACH: RB RECONFIGURATION
5
DCH : RB RECONFIG. COMPLETE
6

Fig. 2

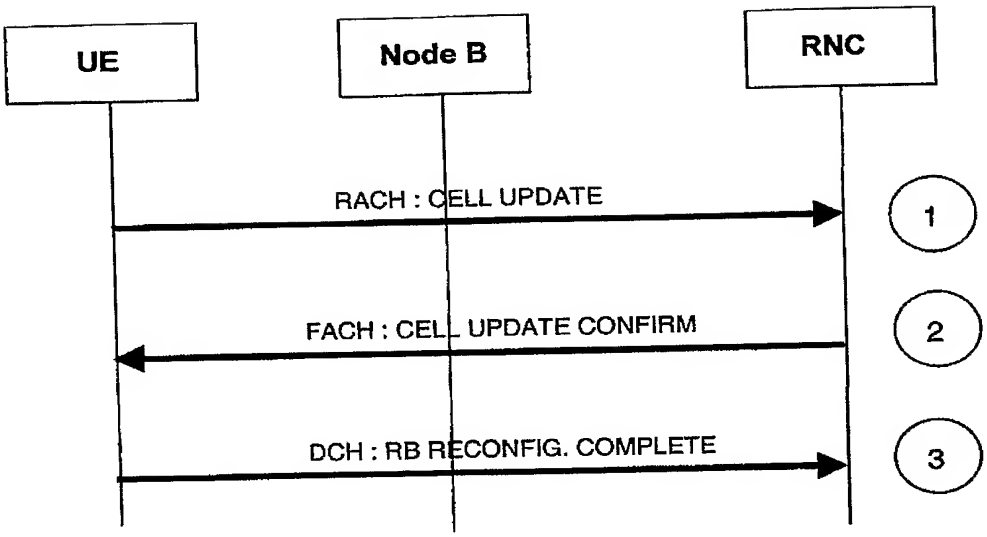
UE
Node B
RNC
RACH : CELL UPDATE
1
FACH : CELL UPDATE CONFIRM
2
DCH : RB RECONFIG. COMPLETE
3

Fig. 3

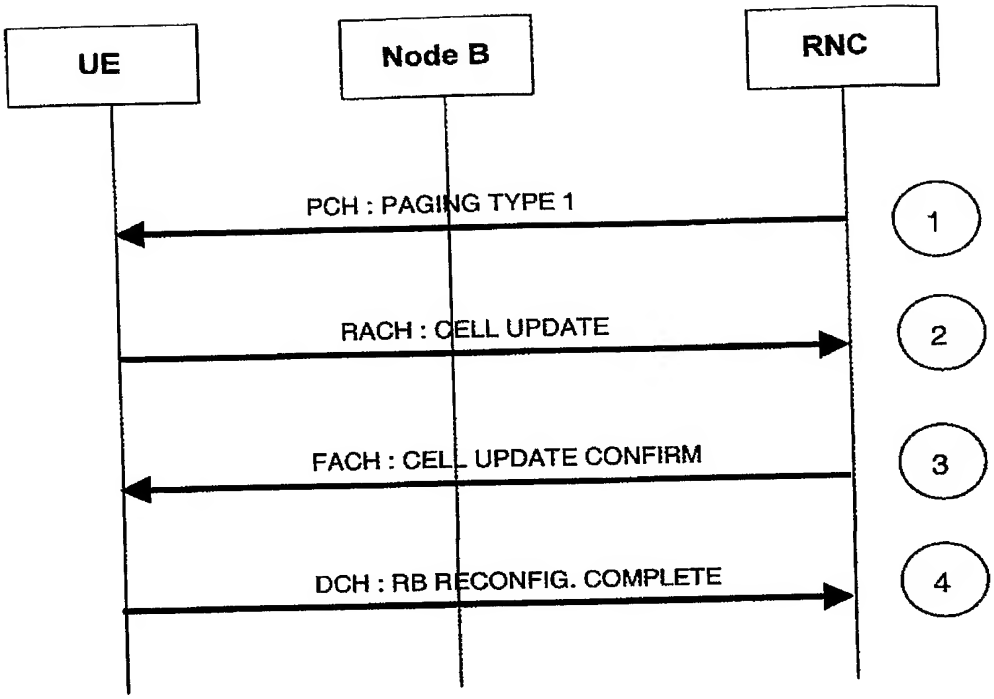
UE
Node B
RNC
PCH : PAGING TYPE 1
1
RACH : CELL UPDATE
2
FACH : CELL UPDATE CONFIRM
3
DCH : RB RECONFIG. COMPLETE
4

Fig. 4

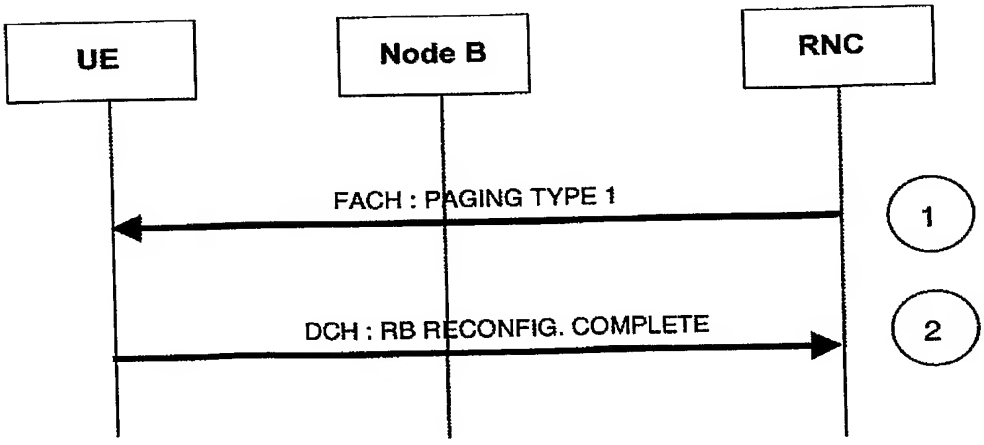
UE
Node B
RNC
FACH : PAGING TYPE 1
1
DCH : RB RECONFIG. COMPLETE
2

Fig. 5

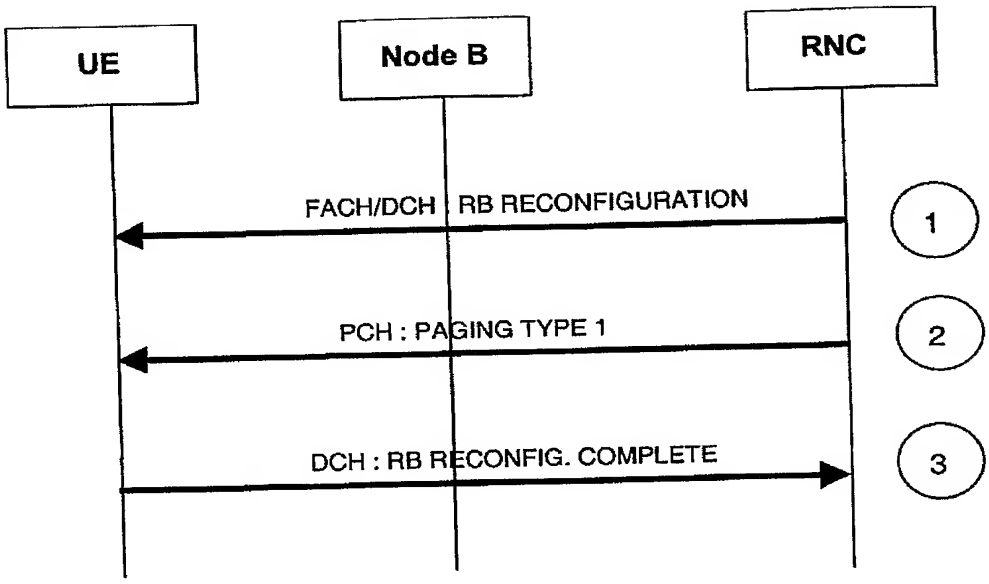
UE
Node B
RNC
FACH/DCH : RB RECONFIGURATION
1
PCH : PAGING TYPE 1
2
DCH : RB RECONFIG. COMPLETE
3

Fig. 6